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DOI:
10.1007/s00198-017-4333-4

Document Version
Peer reviewed version

Link to publication record in King's Research Portal

Citation for published version (APA):
Sheehan, K. J., Filliter, C., Sobolev, B., Levy, A., Guy, P., Kuramoto, L., ... Canadian Collaborative Study on Hip Fractures (2018). Time to surgery after hip fracture across Canada by timing of admission. Osteoporosis International, 29(3), 653–663. https://doi.org/10.1007/s00198-017-4333-4

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TIME TO SURGERY AFTER HIP FRACTURE ACROSS CANADA BY TIMING OF ADMISSION

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ABSTRACT

Purpose: To compare whether time to surgery after hip fracture varies across Canadian provinces for surgically-fit patients and their subgroups defined by timing of admission.

Methods: We retrieved hospitalization records for 140,235 patients 65 years and older, treated surgically for hip fracture between 2004 and 2012 in Canada (excluding Quebec). We studied the proportion of surgeries on admission day and within 3 inpatient days, and times required for 33%, 66% and 90% of surgeries across provinces and by subgroups defined by timing of admission. Differences were adjusted for patient, injury and care characteristics.

Results: Overall, provinces performed similar proportions of surgeries within the recommended three inpatient days, with all provinces requiring one additional day to perform the recommended 90% of surgeries. Prince Edward Island performed 7.0% more surgeries on admission day than Ontario irrespective of timing of admission (difference = 7.0; 95% CI 4.0, 9.9). The proportion of surgeries on admission day was 6.3% lower in Manitoba (difference = -6.3; 95% CI -12.1, -0.6), and 7.7% lower in Saskatchewan (difference = -7.7; 95% CI -12.7, -2.8) compared to Ontario. These differences persisted for late weekday and weekend admissions. The time required for 33%, 66%, and 90% of surgeries ranged from 1-2, 2-3, and 3-4 days, respectively, across provinces by timing of admission.

Conclusions: Provinces performed similarly with respect to recommended time for hip fracture surgery. The proportion of surgeries on admission day, and time required to complete 33% and 66% of surgeries varied across provinces and by timing of admission. This may reflect different provincial approaches to providing access to hip fracture surgery.

MINI ABSTRACT

The extent of Canadian provincial variation in hip fracture surgical timing is unclear. Provinces performed a similar proportion of surgeries within three inpatient days after adjustment. Time to surgery varied by timing of admission across provinces. This may reflect different approaches to providing access to hip fracture surgery.

KEYWORDS

Hip fracture, time to surgery, timing of admission, variation, quantile regression.

INTRODUCTION

Annually, Canadian hospitals admit over 25,000 older adults for hip fracture surgery [1, 2]. This procedure restores mobility potentially adding years to patients' active, independent living.[3] However, surgical delays may diminish the therapeutic effect of surgery by increasing patients' exposure to pro-inflammatory conditions [4, 5]. Aiming at prevention of potentially harmful treatment delays, Canada's federal, provincial and territorial governments established a benchmark of 48 hours from admission for performing 90% of hip fracture surgeries in 2005 [6, 7]. The Canada Health Act of 1984 stipulates uniform access to care for all insured Canadians [8]. However, under the Act each province administers their own health insurance plans which provide coverage for healthcare services. Provincial strategies vary considerably in the administration, funding, and delivery of healthcare services [9, 10]. It is therefore possible that a nationwide policy would fail to produce a uniform result across provinces.

Previous reports show variation in the proportion of surgeries performed within the benchmark time across Canada [6, 11]. Whether this variation reflects an underuse of early surgical services remains unclear. Indeed, for some patients, poor health status on admission may warrant appropriate medically-necessary delays to surgery for preoperative tests and procedures [12-14]. However, whether provincial variation persists among patients without these medically-necessary delays is largely unknown.

This provincial variation may also result from different operating room scheduling practices across the country. Although there is little discretion for hospitals to decide on timing of urgent procedures, access to surgery after hip fracture may be underprioritized due to limited hospital resources. For example, some operating rooms may function at reduced capacity on weekends[15, 16]. Yet, there is inconsistent evidence for an association between admission day and time to surgery after hip fracture[16-23]. This may be explained by a great chance for patients admitted between midnight and noon or on a weekday to undergo surgery on the day of admission than patients admitted in the afternoon or evening or on a weekend. Comparing surgical times across provinces in groups defined by early- or late- weekday, or weekend admission can provide insight about whether the observed variation reflects unmet needs when patients present late on a weekday and on weekends[2].

The objective of this study was to compare Canadian provinces by the proportion of hip fracture surgeries performed within the national benchmark time and by the actual times required to perform various proportion of surgeries. Using hospitalization records from a national database, we estimated the time between admission and surgery for all patients deemed surgically-fit, and then separately in subgroups defined by the timing of admission. Differences between provinces were adjusted for patient, injury and care delivery characteristics. The University of British Columbia Behavioural Research Ethics Board approved this study (H11-02611).

METHODS

Study group

We examined discharge abstracts of 154,389 patients 65 years or older who underwent surgery for non-pathological first hip fracture between January 1, 2004 and December 31, 2012 in Canadian hospitals, except for the province of Quebec. The abstracts were selected from a database maintained by the Canadian Institute for Health Information (CIHI) using procedure codes for hip fracture surgery (CCI:

1VA74^^, 1VA53^^, 1VC74^^, 1SQ53^^, or CCP: 9054, 9114, 9134, 9351, 9359, 9361, 9362, 9363, 9364, 9369). Multiple abstracts with the same patient ID were combined in one care episode using the CIHI rules for hospital transfers[24, 25]. The UK National Institute for Health and Care Excellence (NICE) 124 guideline identified anaemia, anticoagulation, volume depletion, electrolyte imbalance, uncontrolled diabetes, uncontrolled heart failure, acute cardiac arrhythmia or ischemia, acute chest infection, and exacerbation of a chronic chest condition as conditions which warrant medically-necessary surgical delays[26]. We developed a screening algorithm to classify discharge abstracts as having medically-necessary reasons for delay, as described elsewhere[27]. We excluded 10,342 patients with medically-necessary reasons for delay and 1,194 patients with preoperative admission to an intensive care or step-down unit. We excluded 2,182 patients who underwent surgery in a hospital with an annual surgical volume of less than 24 surgeries. Finally, we excluded 436 patients who did not undergo surgery within 21 inpatient days on the premise that longer time to surgery reflected unfitness for surgery, leaving 140,235 patients for analysis [25, 28].

Outcomes

We adopted the CIHI's definition of time to surgery as the number of inpatient days from admission to surgery[29]. The primary outcome was the proportion of surgeries within 3 inpatient days (admission day is day 1) to describe compliance with the benchmark policy for 90% of surgeries. We further characterized time to surgery by the actual number of days required for performing 90% of surgeries. We also estimated the proportion of surgeries on admission day and estimated the time required to perform 33% and 66% of surgeries across provinces and by timing of admission to reflect the greater chance for early surgery among early admissions.

Study variable

The province where surgery was performed was the main study variable. We coded the available provinces as: Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, and Saskatchewan.

Subgroups

We studied the time to surgery by province and separately in subgroups defined by timing of admission. We classified admissions as *early weekday* between 00.00 and 15.59 Monday to Friday, *late weekday* between 16.00 and 11.59 Monday to Friday, or *weekend* on Saturday and Sunday.

Statistical analysis

We reported frequencies and percentages of characteristics of the patients, the type of injury, and care delivery across provinces.

The proportion of surgeries on admission day or within 3 inpatient days across provinces was estimated by dividing the number of surgeries on admission day or within 3 inpatient days by the number of surgically-treated patients. We used the log-rank test to compare the distribution of time to surgery across provinces. We used logistic regression models to test whether the difference in the proportion of patients undergoing surgery on admission day or within 3 inpatient days varied between each province and Ontario[30, 31]. Standard errors of the regression coefficients were estimated by relaxing the independence assumption between patients within hospitals. We reported the difference in proportions between provinces standardizing all covariates to the mean values in Ontario[32]. We selected Ontario as the reference group as almost half of patients underwent surgery in Ontario (48%).

We estimated the time required to perform 33%, 66%, and 90% of surgeries by a weighted average of adjacent order statistics, and their corresponding confidence interval using a binomial method, for each

province[33]. We used a quantile regression model for count data to test whether the time required to perform 33%, 66%, and 90% of surgeries were different between each province and Ontario[34]. This regression model used standard quantile regression on count data that has been transformed into continuous data by adding a uniform random variable[35]. We reported differences between provinces standardized to the distribution of patient, injury, and care delivery characteristics from Ontario[32, 36]. We reported differences statistically significant to 1% on the transformed scale corresponding to a difference of at least one day.

In the regression analyses, the differences between provinces were adjusted for age, sex, prefracture health status (admitted from home with no major comorbidity, admitted from home with major comorbidity or home care, admitted from long term care, admitted from elsewhere)[37], hospital volume (above median in its type)[2], timing of admission (early weekday, late weekday, weekend), admission status (urgent/emergent, other), excess demand (above weekly surgical capacity), transfer history, preoperative procedures, type of fracture, type of surgery (fixation, implant), and calendar year of surgery[38]. In subgroup analyses, timing of admission was removed from the adjustment set. Stata release 14 was used for statistical analyses[39].

RESULTS

Patient characteristics

The largest proportions of patients were women (74%), less than 85 years old (54%), admitted from home without major comorbidity (45%), late on a weekday (38%) (Table 1). Almost half of patients underwent surgery in Ontario (48%) after admission with intertrochanteric hip fracture (48%). Most patients were treated at a hospital with an annual volume of hip fracture surgeries above the median for its type (75%).

Time to surgery overall and by province

Overall, 22.9% of patients underwent surgery on the 1st inpatient day (day of admission), 43.2% on the 2nd inpatient day, 20.9% on the 3rd inpatient days, 7.2% on the 4th inpatients day, and 5.9% on or after the 5th inpatient day. These proportions varied across provinces ($p < 0.001$) (Figure 1). Compared to Ontario, the proportion of surgeries on admission day was 7.0% higher in Prince Edward Island (difference = 7.0; 95% CI 4.0, 9.9), 6.3% lower in Manitoba (difference = -6.3; 95% CI -12.1, -0.6), and 7.7% lower in Saskatchewan (difference = -7.7; 95% CI -12.7, -2.8) after adjustment. In total, 121,867 (86.9%) underwent surgery within 3 inpatient days. There was no difference in the proportion of surgeries within 3 inpatient days between any province and Ontario after adjustment (Table 2).

The time to perform 90% of surgeries was 4 inpatient days for all provinces. The time to perform 33% of surgeries was 2 inpatient days for all provinces, except for New Brunswick and Prince Edward Island where it was 1 inpatient day. The time to perform 66% of surgeries was 2 inpatient days for British Columbia, New Brunswick, Nova Scotia, and Prince Edward Island, and 3 inpatient days for Ontario, Alberta, Manitoba, Newfoundland and Labrador, and Saskatchewan (Figure 2).

Compared to Ontario, there were no differences in the time to perform 33% or 90% of surgeries for all provinces when standardized to characteristics in Ontario. The time to perform 66% of surgeries was one day less in Alberta, British Columbia, and New Brunswick compared to Ontario when standardized to characteristics in Ontario.

Early weekday admissions

For early weekday admissions, 17,249 patients (36.2%) underwent surgery on the admission day. Compared to Ontario, the proportion of surgeries on admission day was 5.4% higher in Prince Edward Island after adjustment (difference = 5.4; 95% CI 1.6, 9.3). Within 3 inpatient days 42,579 (89.4%) had

undergone surgery. This proportion varied across provinces, from a low of 83.1% in Saskatchewan to a high of 92.0% in Prince Edward Island. There was no difference in the proportion of surgeries within 3 inpatient days between any province and Ontario after adjustment (Table 2).

For early weekday admissions, the time to perform 90% of surgeries was 3 inpatient days for Alberta, British Columbia, New Brunswick, Newfoundland and Labrador, and Prince Edward Island, and 4 inpatient days for Manitoba, Nova Scotia, Ontario, and Saskatchewan. The time to perform 33% of surgeries was 1 inpatient day for all provinces, except for Saskatchewan and Manitoba where it was 2 inpatient days. The time to perform 66% of surgeries was 2 inpatient days for all provinces, except Saskatchewan where it was 3 inpatient days (Figure 2).

Compared to Ontario, the time to perform 90% of surgeries for early weekday admissions was one day shorter in Alberta and British Columbia when standardized to characteristics from Ontario. The time to perform 33% of surgeries was one day longer in Manitoba, Newfoundland and Labrador, and Saskatchewan compared to Ontario when standardized to characteristics from Ontario. Compared to Ontario, there were no differences in the time to perform 66% of surgeries for all provinces when standardized to characteristics from Ontario.

Late weekday admissions

For late weekday admissions, 4,786 patients (8.9%) underwent surgery on the admission day. Compared to Ontario, the proportion of surgeries on admission day was 5.0% higher in Prince Edward Island (difference = 5.0; 95% CI 2.9, 7.0), 3.2% lower in Alberta (difference = -3.2; 95% CI -6.2, -0.2), 4.1% lower in Manitoba (difference = -4.1; 95% CI -8.0, -0.2), and 4.1% lower in Saskatchewan (difference =-4.1; 95% CI -7.0, -1.2). Within 3 inpatient days 44,895 (83.9%) had undergone surgery. This proportion varied across provinces, from a low of 78.8% in Saskatchewan to a high of 86.3% in British

Columbia. Compared to Ontario, the proportion of surgeries within 3 inpatient days was 2.8% lower in Prince Edward Island (difference =-2.8; 95% CI -5.0, -0.6) after adjustment (Table 2).

For late weekday admissions, the time to perform 90% of surgeries was 4 inpatient days for all provinces, except for Saskatchewan where it was 5 inpatient days. The time to perform 33% of surgeries was 2 inpatient days for all provinces. The time to perform 66% of surgeries was 3 inpatient days for all provinces, except New Brunswick where it was 2 inpatient days (Figure 2).

Compared to Ontario, there were no differences in the time to perform 33%, 66% or 90% of surgeries for late weekday admissions for all provinces when standardized to characteristics from Ontario.

Weekend admissions

For weekend admissions, 10,073 patients (25.8%) underwent surgery on the admission day. Compared to Ontario, the proportion of surgeries on admission day was 10.1% higher in Prince Edward Island (difference = 10.1; 95% CI 6.7, 13.5), 11.1% lower in Saskatchewan (difference = -11.1; 95% CI -15.9, -6.3), and 9.5% lower in Manitoba (difference = -9.5; 95% CI -15.3, -3.7). Within 3 inpatient days 34,334 (87.9%) had undergone surgery. This proportion varied across provinces, from a low of 82.8% in Saskatchewan to a high of 89.8% in British Columbia. There was no difference in the proportion of surgeries within 3 inpatient days between any province and Ontario after adjustment (Table 2).

For weekend admissions, the time to perform 90% of surgeries was 4 inpatient days for all provinces. The time to perform 33% of surgeries was 2 inpatient days for all provinces, except New Brunswick, Nova Scotia, and Prince Edward Island where it was 1 inpatient day. The time to perform 66% of surgeries was 2 inpatient days for all provinces, except Saskatchewan where it was 3 inpatient days (Figure 2).

Compared to Ontario, there were no differences in the time to perform 90% of surgeries for weekend admissions for all provinces when standardized to characteristics from Ontario. Compared to Ontario, the time to perform 33% of surgeries was one day shorter in New Brunswick, Nova Scotia, and Prince Edward Island when standardized to characteristics from Ontario. Compared to Ontario, the time to perform 66% of surgeries was one day longer in Saskatchewan and Newfoundland and Labrador when standardized to characteristics from Ontario.

DISCUSSION

Main findings

Overall 86.9% of patients underwent surgery within the recommended 3 inpatient days. There was no difference in the proportion of surgeries within 3 inpatient days between any province and Ontario after adjustment. All provinces required one additional day to perform the recommended 90% of surgeries. Prince Edward Island performed more surgeries on admission day than Ontario irrespective of timing of admission. Compared with Ontario, Manitoba and Saskatchewan performed fewer surgeries on admission day among the late and weekend admissions. The time required to perform 33%, 66%, and 90% of surgeries ranged from 1-2, 2-3, and 3-4 days respectively across provinces by timing of admission.

Comparison with other literature

Our findings support the CIHI reports of provincial variation in the crude proportion of patients undergoing hip fracture surgery within the recommended benchmark[40]. We subsequently built on the CIHI reporting by excluding unfit patients from estimates based on the premise that patients with medically-necessary delays may benefit from longer wait times[13, 14, 41]. Further, we accounted for potential variation across provinces in characteristics of patients, their injury, and care delivery[38]. Our findings indicate variation across provinces in the proportion of patients undergoing surgery within the

benchmark decreases after adjustment for these characteristics. We confirmed that four days were required for all provinces to perform the recommended 90% of surgeries, one day beyond the recommended benchmark.

Although the benchmark for surgery after hip fracture was set at the national level, no guideline was provided on how to implement this benchmark. In the current study, we reported differences in the proportion of surgeries performed within intervals of the recommended time across provinces overall and by timing of admission. Some provinces required less days to perform 33% and 66% of surgeries. However, all provinces performed a similar proportion of surgeries within the recommended 3 inpatient days. These results may suggest that provinces work within different structures of care to implement different processes to meet the recommended benchmark[9].

Priority access to operative care may vary between provinces which may face different competing demands for different available resources[42, 43]. In the current study, we reported Prince Edward Island performed more surgeries on admission day than Ontario irrespective of timing of admission. Additional surgical services such as neurosurgery, cardiac, cardiothoracic, or paediatric surgery are not available on Prince Edward Island[44]. Therefore, patients with hip fracture do not compete with these surgical services for access to the operating room on admission. Additionally, earlier surgery in geographically smaller provinces may be due to shorter preoperative inter-hospital transfers than geographically larger provinces[45].

Previous literature points to an inconsistent association between admission day and time to surgery after hip fracture[16-23]. We classified timing of admission as early weekday, late weekday, and weekend. In doing so, we identified overall inequities in patients' access to surgical care after hip fracture with a larger proportion of patients undergoing surgery if admitted early on a weekday (36.2%) than late on a weekday (8.9%) or on weekends (25.8%). These inequities varied by treating province. In the current

study New Brunswick, Nova Scotia, and Prince Edward Island required one less day to perform 33% of surgeries among weekend admissions, and Alberta and British Columbia required one less day to perform 90% of surgeries among early admissions compared with Ontario. In contrast, Manitoba, Saskatchewan, and Newfoundland and Labrador required one more day to perform 33% of surgeries among early admissions, and Saskatchewan and Newfoundland and Labrador required one more day to perform 66% of surgeries among weekend admissions compared to Ontario. Policies and culture may vary across provinces/health regions regarding time and day that hip fracture surgery may be performed with some provinces restricting after hour or weekend cases to emergent cases.

Future Research

Proponents of early surgery recommend an admission to surgery interval of 24 hours[23]. We reported variation in the proportion of surgeries performed on admission day across provinces and by timing of admission. Knowledge of modifiable and non-modifiable factors related to this variation will enable provinces to optimize the processes of moving patients from admission to the operating room. In particular, the time required to transfer patients from hospital at admission to the surgical site may vary by province[45]. The process of prioritizing patients transferred from another site on surgical waiting lists may also vary across provinces. Further, health services are regionally organized in several provinces; future research may focus on factors within provinces associated with benchmark times. In the current study, we report variation in time to surgery after hip fracture across Canadian provinces for patient subgroups defined by timing of admission. Future research should determine whether this variation impacts postoperative outcomes including mortality, complications, resource utilization, and cost.

Limitations

We completed an analysis of routinely collected discharge abstracts with a limited number of variables for adjustment. In particular, patients delayed to hip fracture surgery may present with polypharmacy and additional comorbidities requiring preoperative internal medical consult not captured by the data. We identified surgically-fit patients by the absence of NICE list of conditions for delaying hip fracture surgery[26]. However, other more rare medical conditions such as gastro-intestinal hemorrhage or uncontrolled hypertension may also appropriately delay hip fracture surgery[13]. This may have led to an overestimation of surgically-fit patients in the current study. The time at surgery in hours was not available in the database. Therefore, we adopted the CIHI's definition of time to surgery as the number of inpatient days from admission to surgery[29]. We reported variation in time to surgery by timing of admission across provinces. The reasons for this variation (e.g. staffing, operating room availability, prioritization after-hours and on weekends) was not available. We excluded 2,182 patients who underwent surgery in a hospital with an annual surgical volume less than 24 surgeries. This included 146 patients who underwent surgery in the Yukon, Northwest Territories or Nunavut from analyses[46]. Patients from these regions are often transferred to other provinces for surgery following Territorial – Provincial agreements. Finally, Quebec compiles hospital discharge data in a separate database and does not contribute to the CIHI Discharge Abstracts Database. Therefore, results may not be generalizable to surgeries completed in the Territories or Quebec.

CONCLUSION

A similar proportion of patients underwent surgery within the recommended 3 inpatient days across Canada. The proportion of surgeries on admission day and the time required to perform intervals of the recommended time to surgery varied across provinces and by timing of admission. This may reflect different provincial approaches to improve surgical access after hip fracture. Future research should

examine underlying mechanisms for this variation such as resource availability, prioritization, and funding.

FIGURE CAPTIONS

Figure 1. Proportion of surgeries by province and inpatient day, among all patients. Inpatient days represented by shade, cumulative percentage represented by the width of stacked bars. Provinces defined in Table 1.

Figure 2. Time for 33% (white), 66% (light blue) and 90% (dark blue) of surgeries by province, among all patients (top left panel), early weekday admissions (top right panel), late weekday admissions (bottom left panel), and weekend admissions (bottom right panel). Provinces defined in Table 1.

ACKNOWLEDGEMENTS

We gratefully acknowledge the guidance from the CIHI experts in understanding the discharge abstracts.

FUNDING SOURCES

This research was funded by the Canadian Institutes of Health Research. This funder had no role in the design of this study, execution, analyses, data interpretation or decision to submit results for publication.

CONFLICTS OF INTEREST

The following competing interests are declared (1) PG has received grants from the Canadian Institutes of Health Research related to this work. PG also receives funding from the Natural Sciences and Engineering Research Council of Canada, the Canadian Foundation for Innovation and the British Columbia Specialists Services Committee for work around hip fracture care not related to this manuscript. He has also received fees from the BC Specialists Services Committee (for a provincial quality improvement project on redesign of hip fracture care) and from Stryker Orthopedics (as a product development consultant). He is a board member and shareholder in Traumis Surgical Systems

Inc. and a board member for the Canadian Orthopedic Foundation. He also serves on the speakers' bureaus of AO Trauma North America and Stryker Canada. (2) SNM reports research grants from Amgen Canada and from Merck. (3) JDK is a research assistant and AC is a postdoctoral fellow whose salary is paid by Canadian Institutes of Health Research funding related to this work. (4) BS, LK, KS, CF, EB, LB, JMS, MD, DG, EH declare they have no conflicts of interest.

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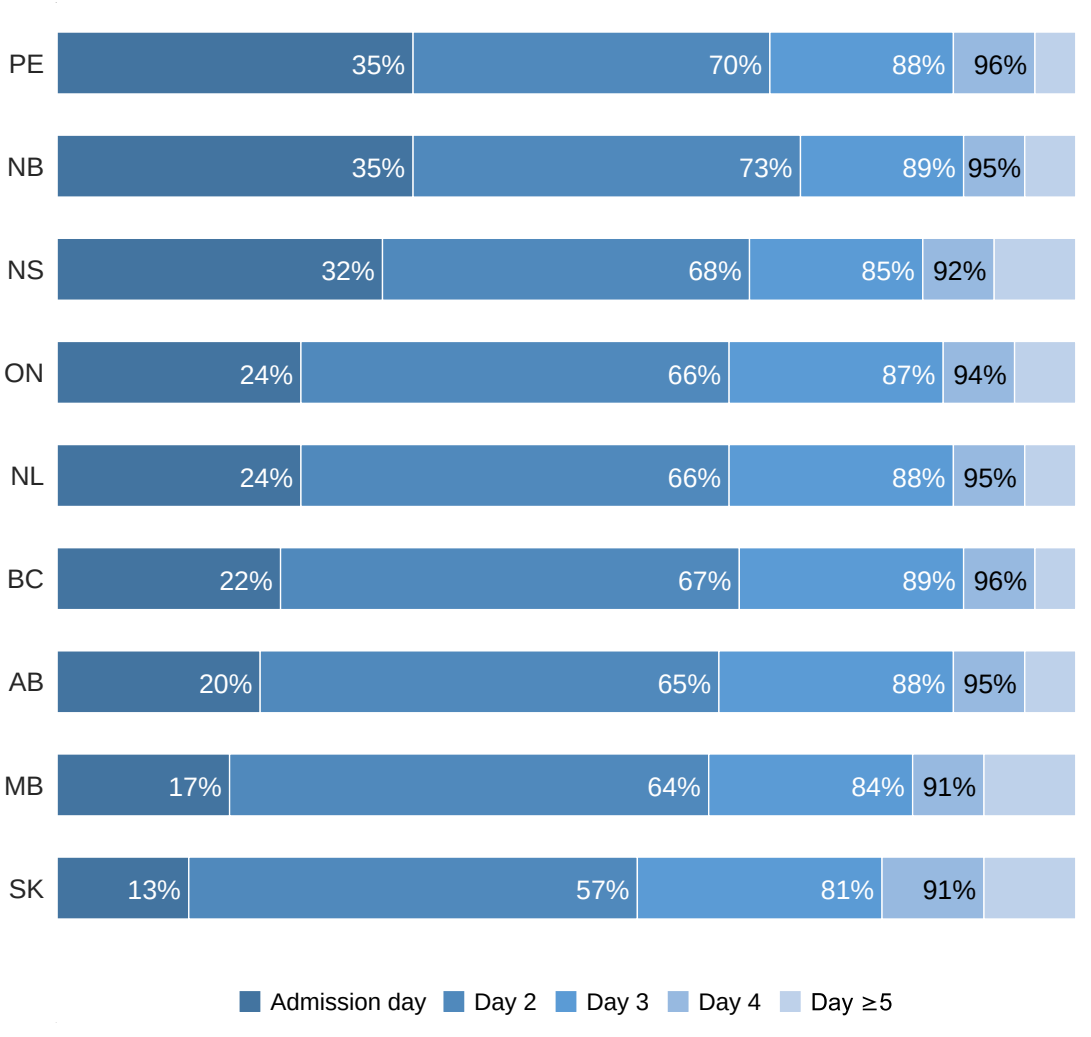
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Day 3
Day 4
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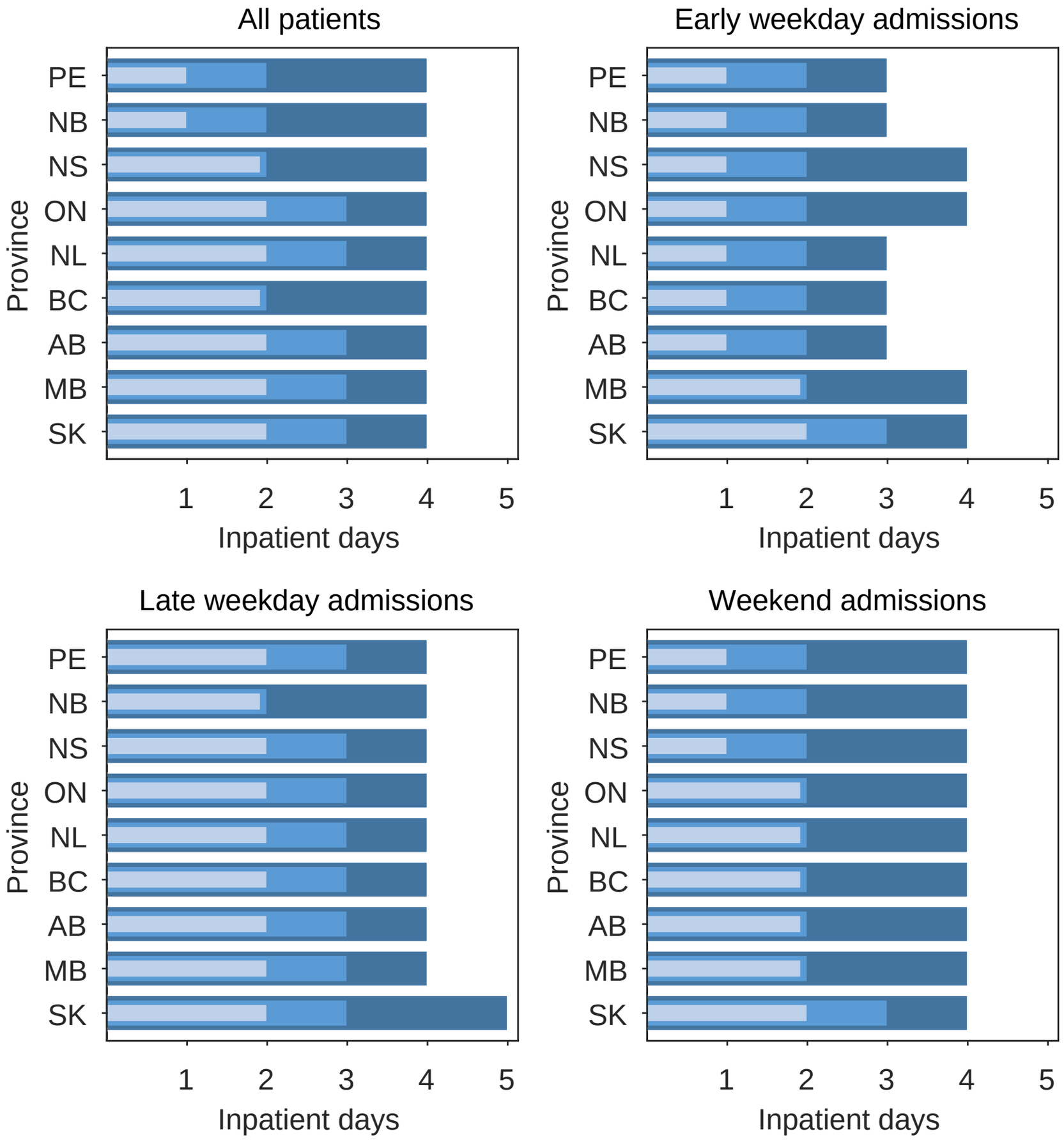
All patients
Early weekday admissions
Late weekday admissions
Weekend admissions
Province
PE
NB
NS
ON
NL
BC
AB
MB
SK
1
2
3
4
5
Inpatient days